FINAL REPORT

Assessment of Geology, Energy, and Minerals (GEM) Resources

LONE MOUNTAIN GEM RESOURCE AREA

(OR-021-22)

HARNEY COUNTY, OREGON

Prepared for

United States Department of the Interior
United States Bureau of Land Management
Scientific Systems Development Branch

March 1983

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Assessment of Geology, Energy, and Minerals (GEM) Resources

Lone Mountain GRA
(OR - 021 - 22)
Harney County, Oregon

Prepared For:

United States Department of the Interior
United States Bureau of Land Management
Scientific Systems Development Branch

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This report was prepared as part of a Phase I Assessment of GEM Resources within designated Wilderness Study Areas in Oregon, Idaho and Nevada.

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DISCLAIMER

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- Dr. Antonius Budding - Oil Shale and Tar Sands
- Mr. Raymond Corcoran - Field Verification
- Dr. James Firby - Paleontology
- Mr. Ralph Mason - Coal
- Mr. Richard Miller - Uranium and Thorium
- Mr. Vernon Newton - Oil and Gas
- Mr. Herbert Schlicker - Industrial Minerals and Geologic Hazards
- Dr. Walter Youngquist - Geothermal
- Dr. Paul Weis - Metals and Non - Metals.

Mr. Edwin Montgomery provided valuable insight and assistance in structuring the project and these reports in order to best serve the purposes of the Bureau of Land Management. We greatly apppreciate his assistance.

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Mr. Tom Mitchell assisted in the stream sediment sampling program. Bondar - Clegg provided the geochemical analysis of stream sediment samples.

Ms. Pamela Ruhl provided clerical and editorial assistance throughout the project. Ms. Sara Mathews assisted with occurrence information and drafting. Mr. Philip R. Jones and Mr. Michael A. Becker produced all documents relating to the project using TERRADATA's word processing and document production systems.

EXECUTIVE SUMMARY

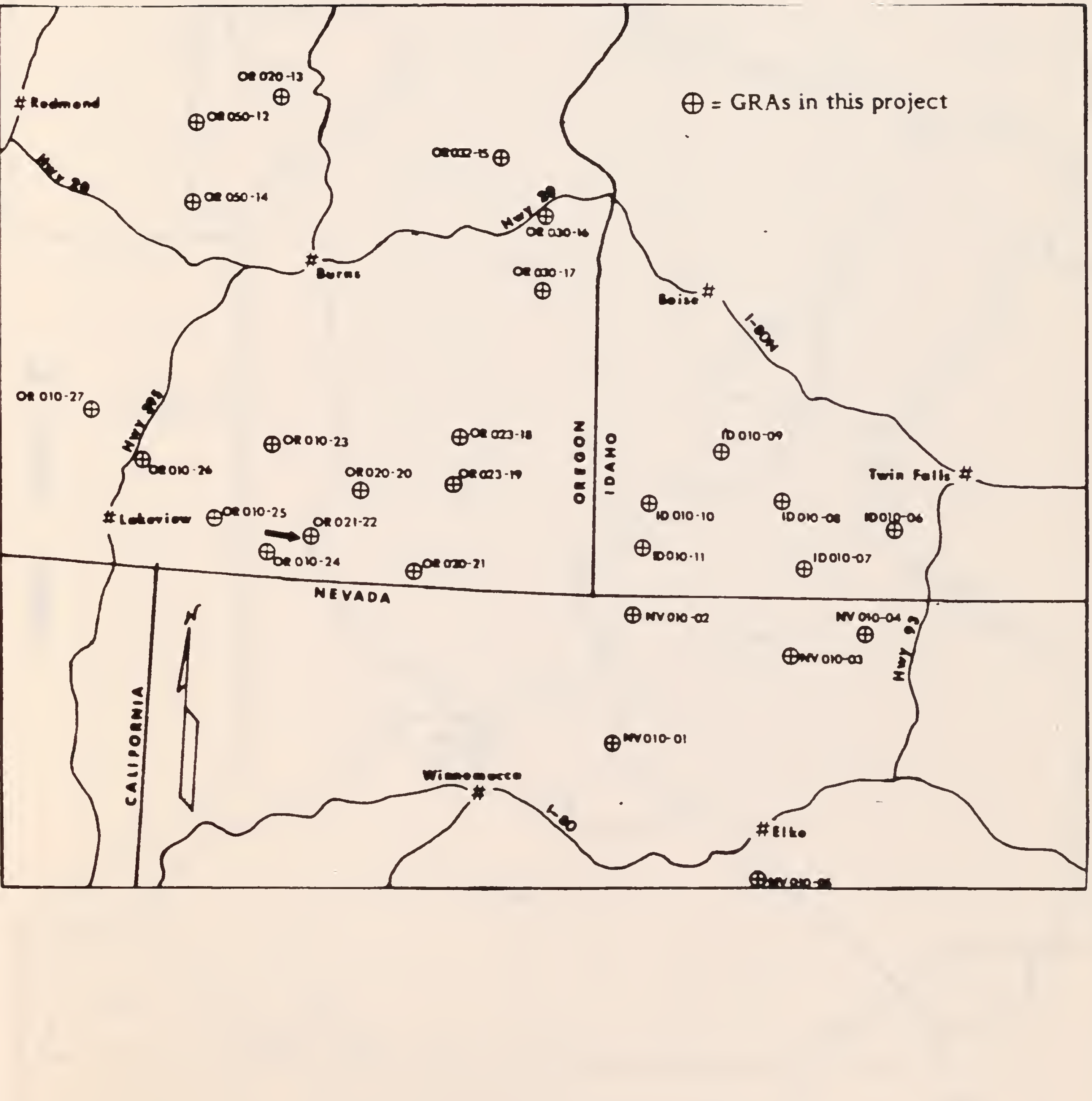
The purpose of this project is to evaluate and classify environments favorable for the occurrence of GEM resources in southeastern Oregon, southwestern Idaho, and northern Nevada. **(See the TERRADATA report entitled "Procedures for the Assessment of Geology, Energy, and Minerals (GEM) Resources.")** GEM resource environments have been rated on a scale that ranges from one to four, with one being least favorable and four being most favorable. Favorability classes two and three represent low and moderate favorability, respectively. Confidence levels range from A to D with A being low confidence and D being high confidence. The confidence levels are directly related to the quantity and quality of the information available for the determination of the favorability classes.

The specific area with which this report deals is the Lone Mountain GEM resource area (GRA OR-021-22) which is located in south-central Oregon (see attached location map). The GRA contains about 900 square miles within Townships 36S through 41S and Ranges 23E through 27E. It contains four WSAs; WSA 2-84, WSA 2-82, WSA 1-146a, and WSA 1-146b which comprise 312,695 acres. The study area is in the Andrews and Warner Lakes Resource Areas of the Burns and Lakeview BLM Districts. It is about 90 miles from Burns, Oregon.

The GRA is within the Great Basin sub-province of the Basin and Range physiographic province. It is underlain by rocks that range from Paleozoic miogeoclinal sediments to Tertiary volcanics and volcaniclastic strata. The area is west of the major structural Antler orogenic belt. Basin and Range fault blocks are common in this portion of Oregon.

The Lone Mountain GRA contains several geologic environments that are variously favorable for GEM resources. The study area is classified 3C for the occurrence of copper and mercury deposits. The 3C rating signifies that the geologic environment, the inferred geologic processes and/or the reported mineral occurrences indicate moderate favorability for the accumulation of copper and mercury, and that the available data provide direct evidence but are quantitatively minimal to support the possible existence of mineral resources. The study area also contains environments similar to those found in other Tertiary basins in which diatomite deposits occur. The confidence level (A) for the classification (3) of the area for potential diatomite resources signifies that although the necessary geologic environment is believed to be present, there is no evidence to support or refute this evaluation.

GRA Location Map



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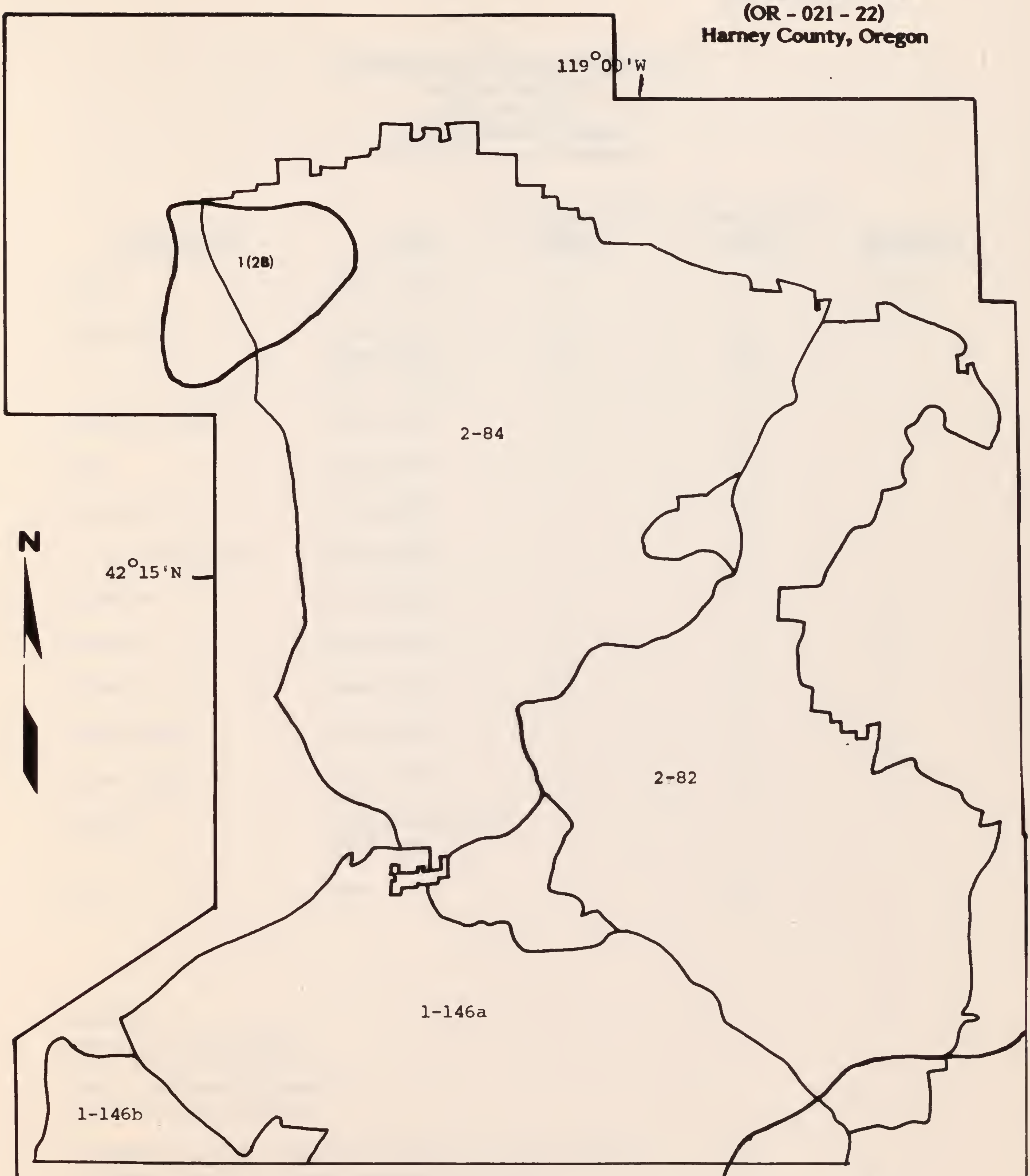
Land Classification Map
Lone Mountain GRA
(OR - 021 - 22)
Harney County, Oregon



Scale 1:250,000
(Adel and Vya 1°x2° NTMS Quadrangle)

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Classification Of Lands Within The
Lone Mountain GRA
(OR - 021 - 22)
Harney County, Oregon
For GEM Resource Potential

COMMODITY	AREA	CLASSIFICATION LEVEL	CONFIDENCE LEVEL	REMARKS
Metals	Entire GRA	3	C	Cu, Hg
Geothermal	Area 1-2B	2	B	
	Area 2-2B	2	B	
	Rest of GRA	1	B	
Uranium/Thorium	Entire GRA	1	A	
Coal	Entire GRA	2	C	
Oil and Gas	Entire GRA	2	B	
Tar Sands/Oil Shale	Entire GRA	1	C	
Limestone	Entire GRA	1	A	
Bentonite	Entire GRA	2	A	
Diatomite	Entire GRA	3	A	
Clinoptilolite	Entire GRA	1	A	
Paleontology	Entire GRA	4	C	
Hazards	See Hazards Map (GRA File)			
ESLs	None	1	C	

LEGEND:
Class 1 - Least Favorable
Class 2 - Low Favorability
Class 3 - Moderate Favorability
Class 4 - High Favorability

Confidence Level A - Insufficient data or no direct evidence
Confidence Level B - Indirect evidence available
Confidence Level C - Direct evidence but quantitatively minimal
Confidence Level D - Abundant direct and indirect evidence

Two subareas within the Lone Mountain GRA are favorable (Class 2) for the occurrence of geothermal resources. The entire GRA is favorable (Class 2) for coal, oil and gas, and bentonite resources (see attached table). The potential for paleontological resources is classified 4C because mammalian fossils are known to occur.

TERRADATA recommends that further surface geologic investigations be undertaken in the Lone Mountain GRA in order to increase confidence levels in the classifications. Detailed geologic mapping and geochemical investigations would be useful in upgrading the land classification of this area. Selective drilling of geochemical and/or geophysical anomalous areas would contribute to the refinement of the confidence levels and favorability ratings in this GRA. Claims that occur is WSA 2-82 should be examined in detail.

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1. INTRODUCTION

This report is one of 27 GRA technical reports that summarize the results of a Phase I assessment of the geology, energy, and minerals (GEM) resources in selected portions of southeastern Oregon, southwestern Idaho, and northern Nevada. The study region was subdivided into 27 GEM resource areas (GRAs), principally for ease of data management and interpretation. The assessment of GEM resources for this project consisted of an interpretation of existing literature and information by experts knowledgeable in both the geographic area and specific commodities. A restricted field verification program also was conducted. It is possible that the assessment would be different if detailed field exploration, geochemical sampling, and exploratory drilling programs were undertaken. (See the TERRADATA report entitled "Procedures for the Assessment of Geology, Energy, and Minerals (GEM) Resources.")

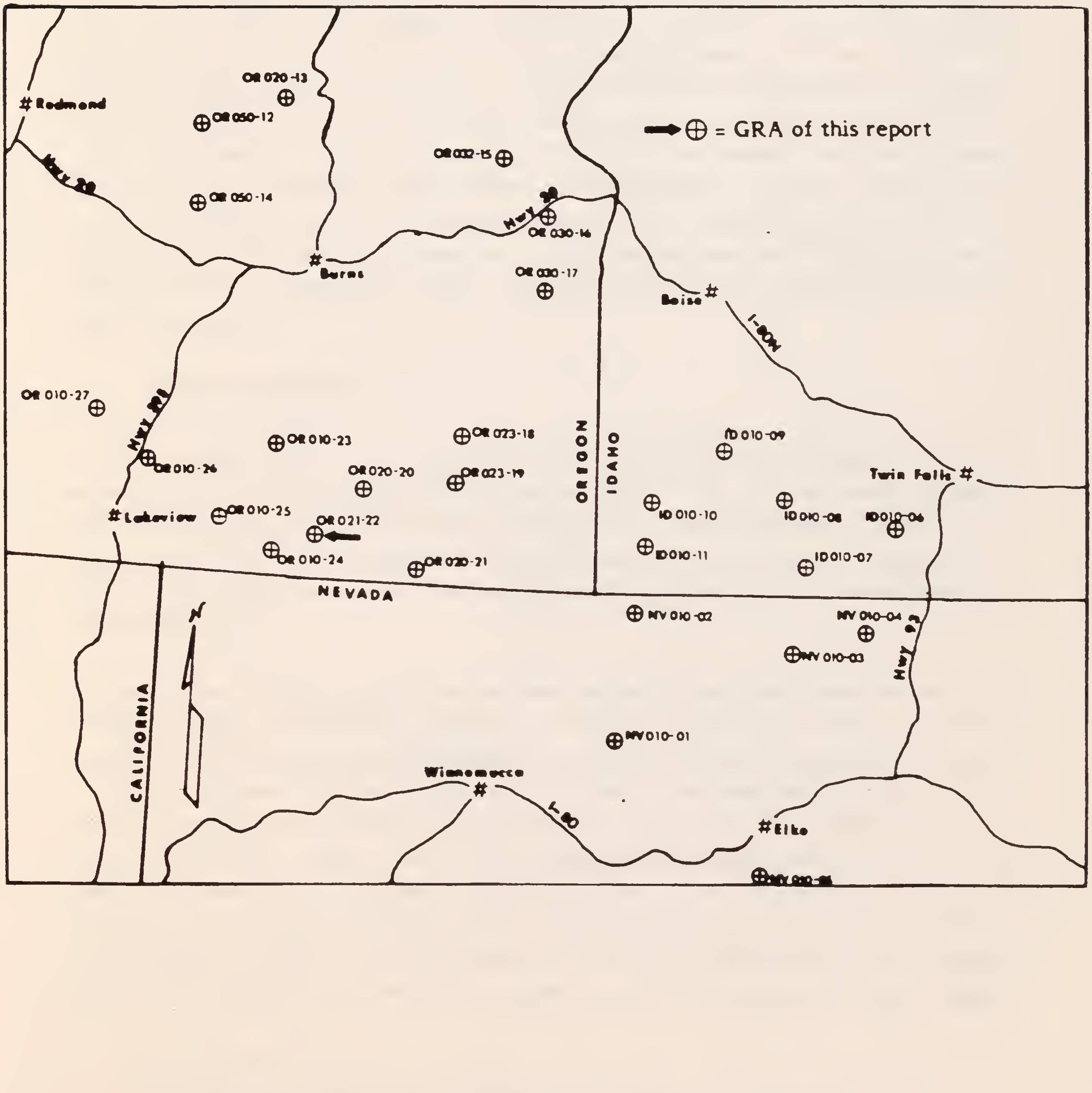
This report summarizes the assessment of the GEM resources potential of the Lone Mountain GRA (OR-021-22). See Figure 1-1. Commodity categories for which this GRA was evaluated are:

- Metals
- Oil and Gas
- Oil Shale and Tar Sands
- Geothermal
- Uranium and Thorium
- Coal
- Industrial Minerals
- Paleontological Resources
- Geologic Hazards
- Educational and Scientific Localities (ESLs)

Geologic environments within the Lone Mountain GRA have been rated with respect to their favorability for the occurrence of these different commodities. The favorability rating scale ranges from one to four, with one being least favorable and four being most favorable. Confidence levels in these ratings also have been assigned. These confidence levels range from A to D, with A being low confidence and D high confidence. Assigned confidence levels are related to the quantity and quality of the information available for the determination of the favorability ratings.

FIGURE 1-1

GRA Location Map



2. DESCRIPTION OF THE LONE MOUNTAIN GRA

2.1 LOCATION

The Lone Mountain GRA (OR-021-22) is in south-central Oregon. It lies between latitudes 41°58'N and 42°28'N and longitudes 118°47'W and 119°21'W. The GRA contains approximately 936 square miles within Townships 36S through 41S and Ranges 23E through 27E (see Figures 1-1 and 2-1). The area contains four Wilderness Study Areas; WSA 2-84 (138,420 acres), WSA 2-82 (97,395 acres), WSA 1-146a (68,360 acres), and WSA 1-146b (8,520 acres). The Lone Mountain GRA is in the Andrews and Warner Lakes Resource Areas of the Burns and Lakeview BLM Districts. The area is about 90 miles from Burns, Oregon which is the nearest transportation center offering a minimum of rail, highway, and/or charter-air services. Access to the contained WSAs is via county maintained dirt or packed-gravel roads. Vehicular access to the interior of the WSAs is poor to non-existent.

2.2 GENERAL GEOLOGY

The Lone Mountain GRA is in the Adel and Vya 1°x2° NTMS Quadrangles. The data available for this area includes NURE investigations[1, 2, 3]*, general mineral resource information[4], and small scale geologic mapping[5]. Detailed geologic information is lacking in most areas. Occurrence information evaluated for this GRA includes MILS, CRIB, NURE, claims, and leases. The overall quantity and quality of commodity specific information is poor.

The Lone Mountain GRA is within the northern section of the Great Basin portion of the Basin and Range physiographic province. The Basin and Range Province consists of generally north-trending fault-block mountains separated by parallel intermontane basins. The mountain blocks are commonly ten to twelve miles wide and are separated by alluviated valleys of comparable width. Elevation ranges from below sea-level at Death Valley to more than 13,000 feet at White Mountains Boundary Peaks. Local relief generally is less that 5,000 feet. The physiography of the Great Basin reflects the structural and lithologic complexity of the underlying bedrock. The Great Basin portion of the Basin and Range Province extends from southern Nevada northward into southern Oregon. The northern-most extremity is located just north of the town of Burns, Oregon.

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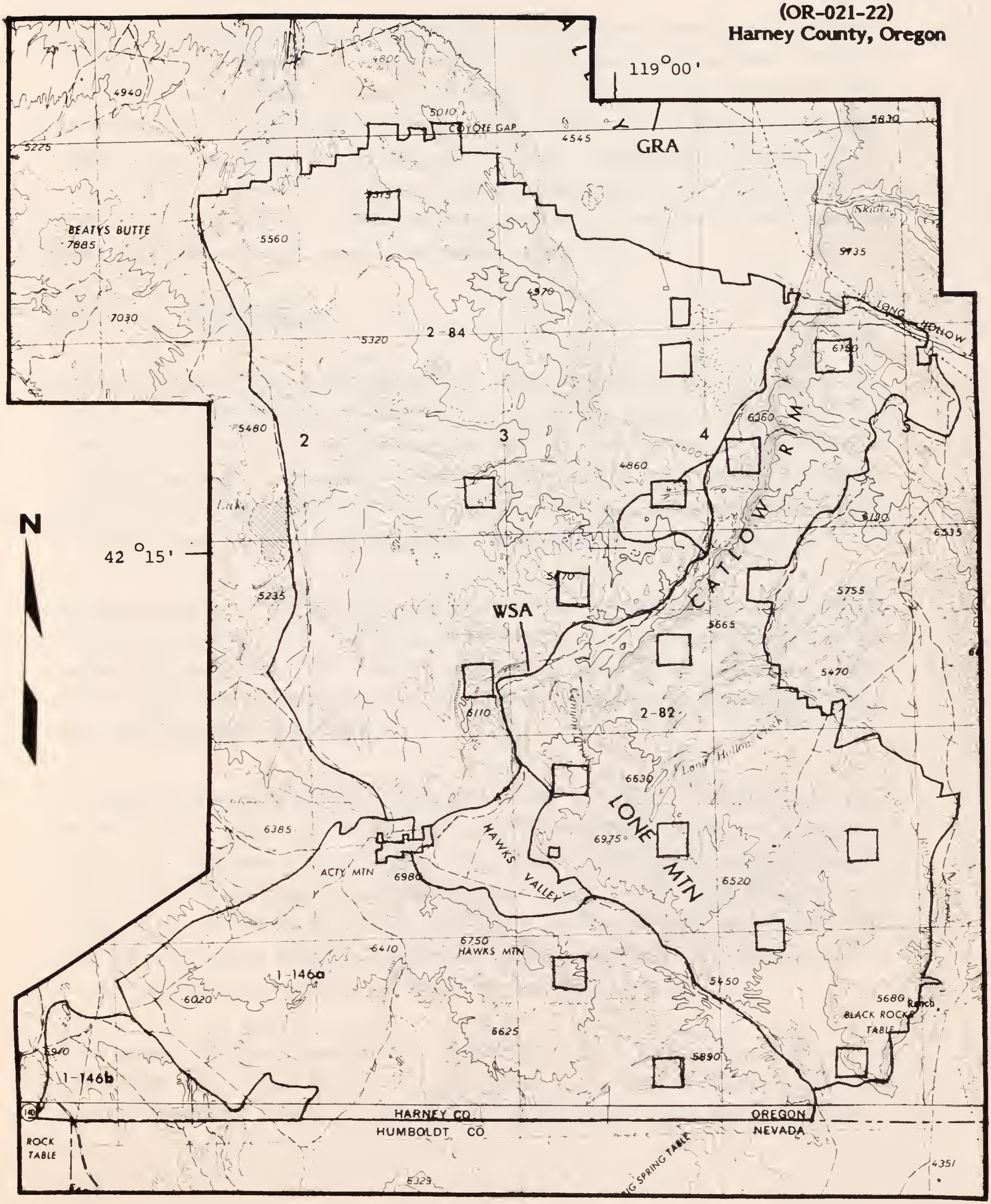
* In this report, citations are superscripted numbers. They refer to bibliographic entries listed in Appendix A, References Cited.

FIGURE 2-1

Topographic Map
Lone Mountain GRA
(OR-021-22)
Harney County, Oregon



Scale 1:250,000
(Adel and Vya 1°x2° NTMS Quadrangle)

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The part of the Basin and Range Province that lies in southern Oregon extends eastward from the Cascade Range to the eastern limits of the Trout Creek Mountains. This part of the province is dominantly underlain by Cenozoic volcanic strata. Pre-Tertiary rocks are exposed in only two places in the Oregon part of the Basin and Range Province; in the Pueblo Mountains and in the Trout Creek Mountains of southeastern Harney County. Very little is known about the Pre-Tertiary basement elsewhere in the province. A sparce amount of data is available regarding the depth to the Pre-Tertiary basement rocks and the thickness and nature of the Tertiary cover rocks.

2.2.1 Geomorphology

The Lone Mountain GRA is about 60 percent upland area and 40 percent lowland area. The area is located at, and includes part of, the southern end of Catlow Valley. It is bounded on the east by a prominent scarp (Catlow Rim) that rises abruptly to a height of 1,800 feet above the valley floor. Catlow Valley is one of seven prominent sub-parallel grabens in the Oregon part of the Basin and Range Province. Others for which GRAs have been named include Crump Lake Valley, Guano Valley, and Pueblo Valley.

The north-central part of the GRA, Catlow Valley proper, consists of a bolson with an overlaying flat-lying playa. The playa is 33 miles long and 16 miles wide and extends northward from the GRA. The playa contains several large ephemeral lakes, and smaller perennial lakes fed by intermittent streams. Other characteristics of the playa include relict beach ridges and dune fields.

The upland surface includes Beaty's Butte to the west, Lone Mountain and Hawks Mountain to the south, and the dip slope of the Pueblo-Steens Mountains to the east. Catlow Rim separates WSA 2-82 from WSA 2-84. This fault-line scarp defines the western edge of the Pueblo-Steens fault block. Intermittent streams drain the GRA. There are a few perennial streams that flow westerly out of the Pueblo-Steens Mountains. Numerous ephemeral lakes occur on the upland surfaces. Drainage patterns are generally dendritic except at Beaty's Butte where they are radial.

Total relief in the Lone Mountain GRA is 3,300 feet. Catlow Rim is the area of greatest local relief, nearly 2,000 feet. The highest point in the GRA is Beaty's Butte. The lowest point is in the bottom of Catlow Valley. Catlow Valley has no external drainage.

2.2.2 Lithology and Stratigraphy

Paleozoic and Mesozoic units may occur at undetermined depths in the Lone Mountain GRA since this area is within the margins of both the western Triassic and the western Late Paleozoic depositional basins[6]. None of these units, however, are exposed in or near the GRA. Tertiary basalt flows are the oldest rocks exposed in the Lone Mountain GRA (Figure 2-2).

The majority of rocks in this GRA are Tertiary volcanogenic strata. The Tertiary volcanic rocks comprise three major groups distinguished on the basis of chemistry and age. Eocene (?) to Early Miocene basaltic to rhyolitic rocks underlie areas throughout the GRA. These rocks are part of widespread calc-alkalic volcanism related to subduction along the Pacific margin, which produced mostly andesitic to rhyolitic rocks.

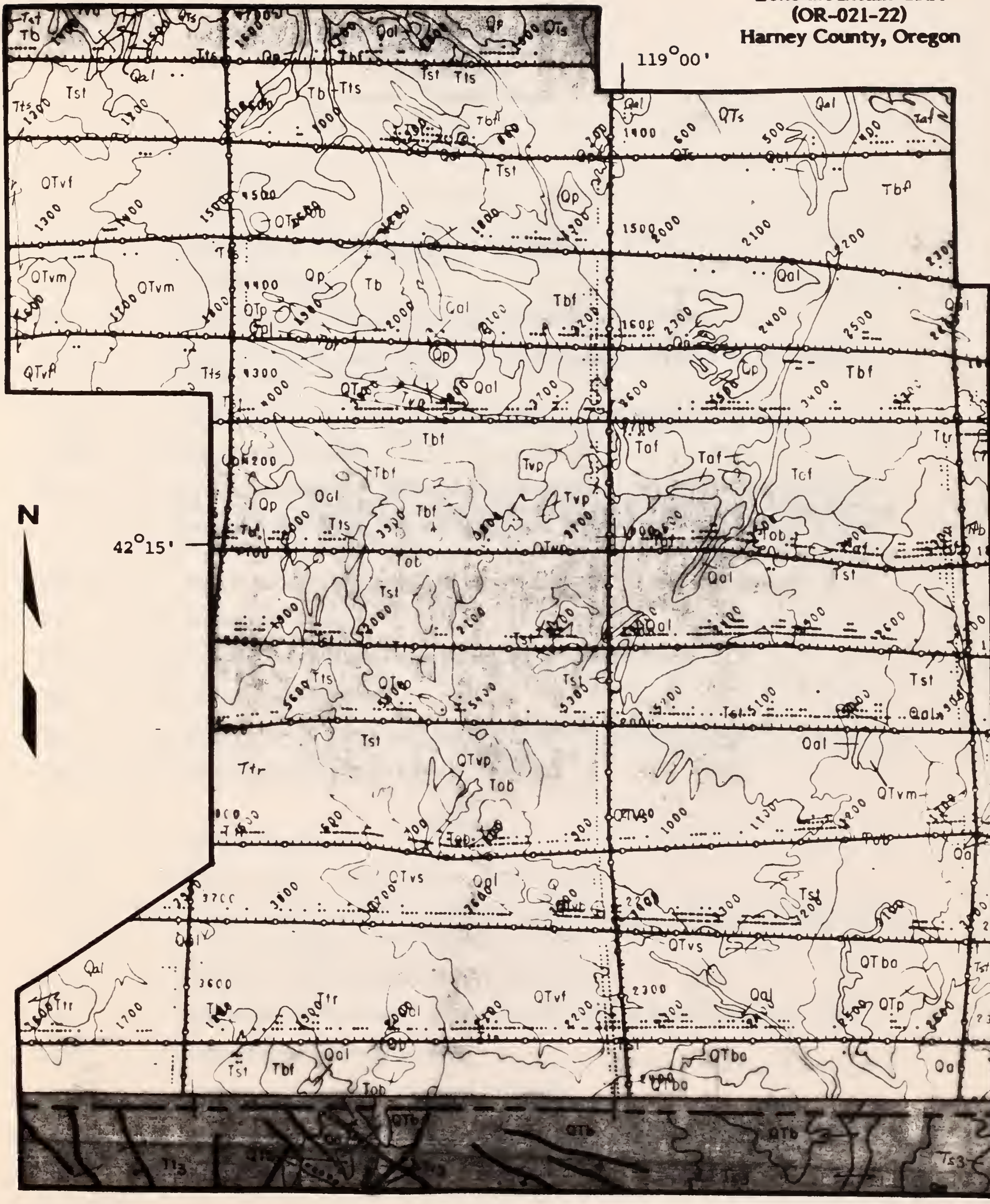
Representatives of the second Tertiary volcanic group, Mid-Miocene dacitic to rhyolitic flows ash-flow tuffs, occur throughout the GRA. Some of these rocks are peralkaline or have peralkaline affinities. They are related to the beginning of extensional tectonics in the area. Volcaniclastic rocks are associated with the second Tertiary volcanic group and consist mainly of tuffaceous fluvio-lacustrine shales, mudstones, sandstones, and conglomerates. Air-fall tuff and diatomaceous sedimentary rocks also occur.

A third volcanic group consists mostly of Middle to Late Miocene olivine basalt flows. These rocks are probably correlative with the flood basalts of the Columbia River Plateau Province. Relatively young basalt flows and other volcanic ejecta occur in the northern and southeastern parts of the GRA.

Quaternary exogenous domes, flows, and flow breccias of rhyodacitic composition occur in parts of the Lone Mountain GRA. A small amount of Quaternary basalt and/or andesite also occurs in parts of the study area.

FIGURE 2-2

Geologic Map
Lone Mountain GRA
(OR-021-22)
Harney County, Oregon



Scale 1:250,000
(Adel and Vya 1°x2° NTMS Quadrangle)

FIGURE 2-2
(Continued)

Geologic Map Legend For
Lone Mountain GRA
(OR-021-22)
Harney County, Oregon

Adel
(North)

Qp	- Playa Deposits
Qal	- Alluvium
QTp	- Pyroclastic Rocks of Basaltic Cinder Cones
QTls	- Landslide Debris
QTs	- Lacustrine, Fluviatile, and Acolian Sedimentary Rocks
QTvf	- Large, Complex Exogeneous Domes and Related Flows and Flow Breccias of Rhyodacitic Composition
QTvm	- Strato-Volcanoes Dominantly of Basaltic or Andesitic Composition
QTba	- Basalt and Andesite
Tst	- Semi-Consolidated Lacustrine Tuffaceous Sandstone and Siltstone, Ash and Ashy Diatomite, Conglomerate and Minor Fanglomerate, Boulder-Bearing Slope Wash, Vitric-Crystal and Vitric-Lithic Tuff, Pumice Lapilli Tuff, and Tuff Breccia
Tob	- Thin, Vesicular, Subophytic to Intergranular, Diktytaxitic Basalt Flows
Tb	- Basalt
Tts	- Fine-Grained Tuffaceous Sedimentary Rocks and Tuffs
Taf	- Platy Andesite Flows
Tbf	- Massive Basalt Flows and Minor Interbeds of Tuff and Scoria
Tvp	- Tuffaceous Sedimentary Rocks and Tuffs

Vya
(South)

Qa	- Alluvial Deposits
QTb	- Basalt Flows: Locally includes maar deposits
Tt_3	- Welded and Non-Welded Silicic Ash-Flow Tuffs: Locally includes thin units of air-fall tuff and sedimentary rock.
Tr_3	- Rhyolitic Flows and Shallow Intrusive Rocks
Ts_3	- Tuffaceous Sedimentary Rocks: Locally includes minor amounts of tuff.
	- Fault (dashed where inferred).
	- Geologic contact (dashed where inferred).

2.2.3 Structural Geology

The tri-state area of northeastern Nevada, southern Oregon, and southwestern Idaho is characterized by several major structural elements. During the Early Paleozoic this area was the site of marine sedimentation in the north-northeast trending Cordilleran geosyncline. Sedimentation persisted in three sub-parallel belts until the end of the Devonian Period. One sedimentation belt was located in the eastern half of Nevada and received nearshore to littoral deposits of shallow-water carbonates with a minor amount of interbedded shale and sandstone. The second sedimentation belt was in the western half of the state and was the locus of transitional, progressively deeper water deposits. The third belt, located further west, was the site of eugeoclinal deposits.

In Late Devonian time, the Antler Orogeny developed along a north-northeast trending swath through northwest Elko County, Nevada, and on into southwestern Idaho. The Lone Mountain GRA lies west of the axis of the Antler orogenic belt. As a direct result of the Antler orogenic uplift, a Pennsylvanian clastic wedge developed along the margins of the uplift. The orogeny culminated in a period of extensive thrust faulting that includes the Roberts' Mountain thrust.

The Sonoma Orogeny occurred in the Permian in north-central Nevada[6]. This deformational episode included more thrust faulting south of the Lone Mountain GRA.

Another structural episode in this area was Basin and Range block faulting in response to extensional forces.

2.2.4 Paleontology

Late Tertiary and Early Quaternary sedimentary rocks within the GRA contain several varieties of flora and fauna. Tuffaceous lacustrine sediments contain Late Miocene mammalian vertebrate fauna in fine-grained sandstone and siltstone facies[7]. Tertiary diatomites may contain occasional fish and leaf fossils common to lacustrine environments. All other exposed volcanic lithologies are essentially devoid of fossils. Older fossil-bearing Paleozoic and Mesozoic marine and terrigenous units are not exposed in the Lone Mountain GRA.

2.2.5 Historical Geology

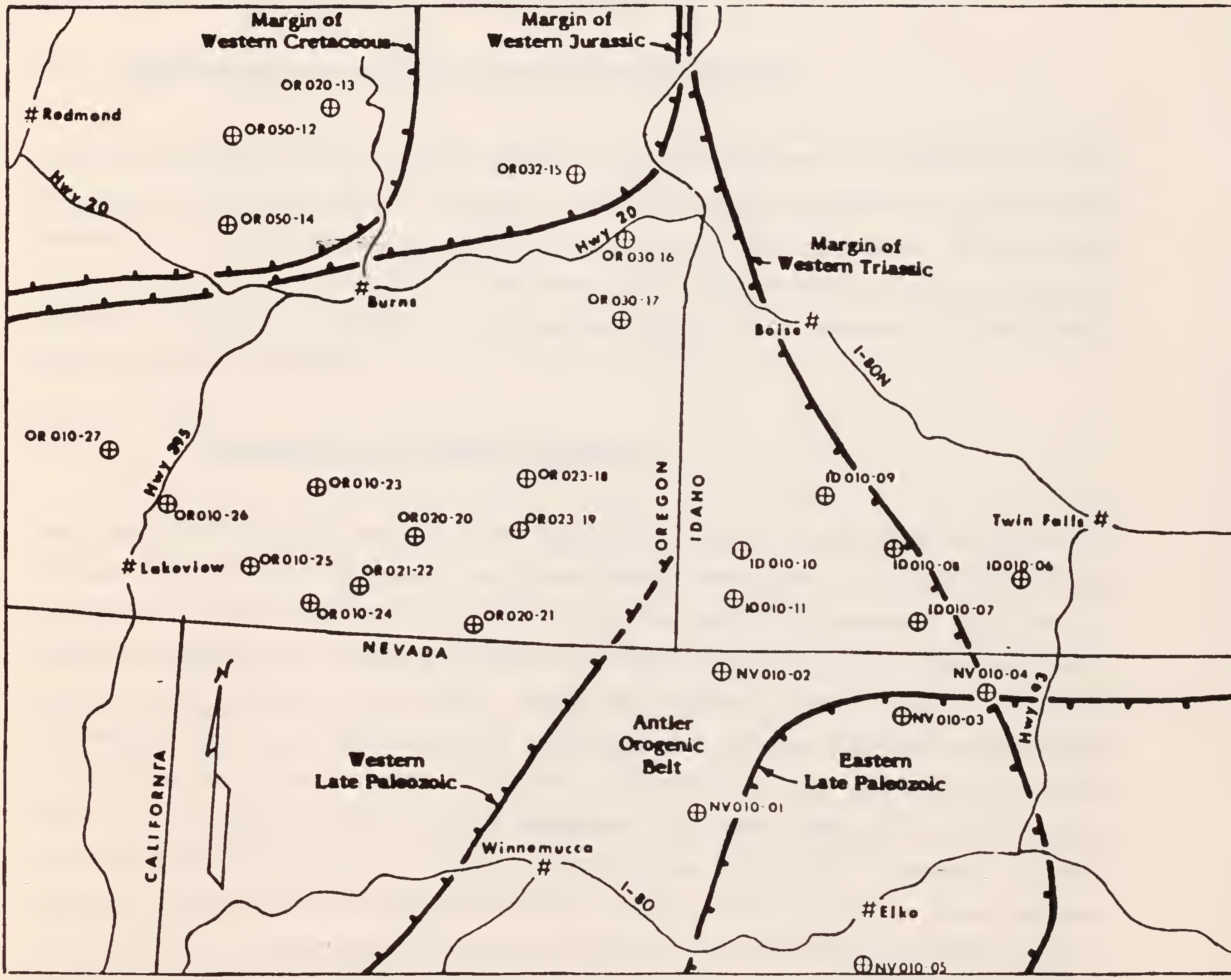
The present geologic character of the Great Basin resulted from the progressive development of the western portion of the North American continent throughout geologic time. Beginning in the Late Precambrian and continuing into the Middle Paleozoic, eastern Nevada, western Utah, southwesternmost Idaho were characterized by a miogeoclinal environment in which shelf margin carbonates, shales, and sandstones were deposited. In contrast, western Nevada and southern Oregon were in a eugeoclinal environment in which dark shales, radiolarian cherts and basaltic materials (Steinman's Trinity) were formed.

The Middle Paleozoic (Late Devonian-Early Mississippian) Antler Orogeny deformed and thrust the eugeoclinal sediments over the shelf-type sediments to the east, resulting in a north-trending highland in Central Nevada. A vast amount of fine-grained detritus was shed eastward during the Mississippian, producing thick upper Paleozoic shales in eastern Nevada and western Utah. Erosion of the Antler Highlands resulted in the deposition of coarse sediments during the Early Pennsylvanian. Thousands of feet of sandstone and conglomerate were deposited in northern Nevada arond the margins of the Antler Highlands. Late Pennsylvanian and Permian shallow water sediments overlapped and overstepped the roots of the eroded highlands. Sediments deposited over the eroded Antler Highlands in the Permian were predominantly of the deep-water variety. The next significant tectonic episode (the Sonoma Orogeny) thrust the ocean floor siliceous and volcanic materials eastward over the shallow water, clastic sedimentary rocks that covered the ancient Antler Highland.

Development of western North American in the Mesozoic was dominated by oceanic plate subduction along the continental margin that resulted in a complex history of concomittant sedimentation, deformation, and igneous activity. During this time, the well-defined overthrust belt that extends from Canada to Mexico was formed. This deformation occurred during the Sevier (Late Jurassic to Latest Cretaceous) and Laramide orogenies (Latest Cretaceous to Early Tertiary Eocene).

FIGURE 2-3

Paleogeographic Map[6]
Oregon-Idaho-Nevada
Tri-State Area



Widespread silicic volcanic rocks formed in the Great Basin in Early and Middle Cenozoic time (primarily 20-34 million years ago). During Late Cenozoic time volcanic activity of the Great Basin changed to a bimodal basalt-rhyolite assemblage that reflects the taphrogenic character of the region. It was also during this time that the tectonic character of the region changed from one of compression to one of extension and led to the development of the Basin and Range structure.

2.3 ENVIRONMENTS FAVORABLE FOR GEM RESOURCES

The Lone Mountain GRA contains several environments that are favorable for the occurrence GEM resources. The area contains environments that are moderately favorable for the occurrence of metallic and industrial mineral resources. Environments also occur in this GRA that have a low favorability for geothermal, coal, oil and gas, or bentonite resources. Environments for paleontological GEM resources are considered highly favorable in this area.

2.3.1 Environments for Metals Resources

The Lone Mountain GRA has a moderate favorability for environments containing metals that are analogous to those found in the Pueblo-Steens Mountains. The eastern portion of this GRA is located on the dip slope of the Peublo-Steens Mountains fault blocks. Metallic mineralization in the Pueblo-Steens Mining District occurs in silicified fault-zones in pre-Tertiary and Tertiary lavas and related volcanic rocks. Primary commodities that occur in the district are copper and mercury minerals, accompanied locally by accessory gold. Similar hydrothermal deposits may occur in the Lone Mountain GRA as the geology and structure are analogeous. The Hawks Mountain, Acty Mountain and Lone Mountain areas of the GRA were sampled by the BLM[8]. Analysis of stream sediment samples showed concentrations that were consistent with the concentrations expected from the source lithologies and within the range of expected analytical error. Specific areas of hydrothermal alteration and bleaching, recognition criteria that are common to these types of deposits, are not noted in the study area.

2.3.2 Environments for Oil and Gas Resources

The Lone Mountain GRA has a low favorability for potential oil and gas resources. Potentially favorable sub-surface environments include western Triassic and western

Late Paleozoic formations, and Miocene Lake Bruneau units[6]. Prospective environments are overlain by Tertiary volcanics, therefore, all of the evidence is indirect. If the environments favorable for the accumulation of oil and gas do exist, then the associated Basin and Range faults might provide essential structural traps.

2.3.3 Environments for Oil Shale and Tar Sands Resources

The Lone Mountain GRA contains no environments favorable for the occurrence of oil shale or oil impregnated sand[9]. The area is underlain predominantly by Tertiary volcanics. Potential sedimentary hosts are largely tuffaceous and contain only minor amounts of non-volcanic clastic material and carbonates. Favorable lithologies are not present.

2.3.4 Environments for Geothermal Resources

Two subareas within the Lone Mountain GRA contain environments that have low favorability classifications for potential geothermal resources[10]. The favorable environments are centered around young volcanic features on the east flank of Beaty's Butte and in the southeast corner of the GRA. The environments are considered favorable solely on the basis of their association with young volcanics that may provide potential residual heat soruces. However, there are no known major faults or geothermal occurrences within the area to further substantiate the classification. Geothermal environments in this part of Oregon generally occur along Basin and Range faults associated with major grabens. These criteria are not met by this study area.

2.3.5 Environments for Uranium and Thorium Resources

There are no environments favorable for the occurrence of uranium or thorium resources in the Lone Mountain GRA[11]. Favorable source rocks, potential reductants, and evidence of inferred processes of mineralization are all lacking in this study area.

2.3.6 Environments for Coal Resources

The Lone Mountain GRA contains low favorability for the occurrence of coal and lignite deposits[12]. The chances for coal or carbonaceous materials to have formed in the study area are remote. The geology of the Lone Mountain GRA region does not support

environments favorable for the formation of coal deposits. The area is underlain or is mantled with accumulations of highly tuffaceous sediments and related volcanic products. There is no evidence to support the inference that a coal-forming environment existed within this GRA.

2.3.7 Environments for Industrial Minerals Resources

The Lone Mountain GRA contains environments favorable for the accumulation of diatomite and bentonite GEM resources. Environments favorable for diatomite occur in lacustrine strata interbedded with volcanic sequences. Bentonite may occur as an alteration product of felsic volcanic rocks in the GRA(13).

2.3.8 Environments for Paleontological Resources

There are five Miocene age mammmalian fossil localities in the Lone Mountain GRA near Beaty's Butte. The fossils occur in Tertiary sedimentary units. The known occurrences are in map units Tcs, QTvm, QTvf, and Tst. In reality, they should all be indicated in unit Tts as this unit is compound of mostly tuffaceous sediments deposited in lacustrine or fluvial environments with minor air-fall tuffs(7).

2.3.9 Environments for Geologic Hazards

Potential geologic hazards in the Lone Mountain GRA consist of mapped and interpreted faults, landslides, and volcanic centers(13). These features were noted from aerial photographs, geologic maps, and topographic maps. There is no historical record of violent seismic or volcanic activity the area. The potential for mass movement exists along all over-steepened slopes within the GRA.

2.3.10 Educational and Scientific Localities

There are no known ESLs in the Lone Mountain GRA.

3. ENERGY AND MINERAL RESOURCES IN THE LONE MOUNTAIN GRA

The Lone Mountain GRA is moderately favorable for the occurrence of a few GEM resources.

3.1 KNOWN DEPOSITS

The Lone Mountain GRA has no known deposits.

3.2 OCCURRENCES

The Lone Mountain GRA does not contain any CRIB, MILS, or NURE related occurrences.

3.3 CLAIMS

The Lone Mountain GRA contains no known mining claims as of 15 August, 1982 (personal communication with G. Brown, Burns BLM Office).

3.4 LEASES

An area equivalent to 8.5 townships in the west and southwest parts of the Lone Mountain GRA is currently leased or under lease application for oil and gas. Lease information is current as of 15 August, 1982.

3.5 DEPOSIT TYPES

There are no known deposits in the Lone Mountain GRA. Anticipated deposit types are typical hydrothermal vein and replacement-type bodies with associated silicification and bleaching. Stratiform deposits of diatomite in lacustrine sequences also are anticipated.

3.6 MINERAL ECONOMICS

Commodities for which the Lone Mountain GRA is considered moderately favorable include mercury, copper, and diatomite.

3.6.1 Mercury

In 1981, mercury was used in the electrical apparatus industry, 56 percent; mildew-proofing paint, 14 percent; electrolytic production of chlorine and caustic soda, 13 percent; instrumentation, ten percent; and seven percent in other applications[14]. The total domestic mine and secondary production of mercury in 1981 was 39,148 flasks, nearly 11 percent of which was derived from recycling. The 1981 apparent consumption was 59,244 flasks. Therefore, the net import reliance was 39 percent of the apparent consumption[14].

The annual price of mercury increased from $135.71 per flask in 1977 to $413.82 per flask in 1981[15]. Conversely, there has been a slight decrease in domestic production, price and consumption of mercury in the first half of 1982[16]. Demand for mercury is expected to increase at an annual rate of less than one percent through 1990.

3.6.2 Copper

The principal consumers of copper in 1981 were the electrical industry, 57 percent; and the construction industry, 17 percent. Twelve percent of consumption was in industrial machinery; eight percent was used in transportation, and six percent went for other uses. Copper mining and the refining of copper ores have produced the entire domestic supply of primary arsenic, selenium, and tellurium, most of the primary platinum and palladium, nearly 43 percent of the primary gold, 37 percent of the primary silver, and 30 percent of the primary domestic molybdenum[17].

Domestic production of copper fell six percent in July, 1982, whereas net imports declined 17 percent in the same month. This is 14 percent below the July, 1981 level[18]. Consumption of refined copper decreased 24 percent while stockpiles have increased six percent. The price of copper reached an all time high of $1.45 per pound in February, 1980. Although the price has fluctuated, it has declined steadily to around $0.63 to $0.71 per pound in August, 1982[19].

The United States demand for copper is expected to increase at an annual rate of about three percent through 1990[18]. The United States is estimated to have a net import reliance of five percent of apparent copper consumption, as of January, 1982.

3.6.3 Diatomite

Diatomite is used primarily as a filter-aid, as an industrial filler, and other miscellaneous applications, including insulation[20]. Diatomite was produced by seven companies in four states in 1981[21]. California accounted for more than 50 percent of total diatomite production. The United States is the largest world producer and consumer of diatomite. The United States also is a net exporter of this commodity. Demand for diatomite is expected to increase at an annual rate of three percent through 1990. World resources of diatomite are adequate for the foreseeable future, but the need for near-market sources will encourage development of new sources.

3.7 STRATEGIC AND CRITICAL MINERALS AND METALS

Mercury and copper are the only strategic commodities for which the Lone Mountain GRA is considered favorable. (See Table 3-4 in TERRADATA's report entitled "Procedures for the Assessment of Geology, Energy, and Minerals (GEM) Resources.") The entire GRA is classified as having a low favorability (Class 3C) for mercury and copper.

4. CLASSIFICATION OF LAND FOR GEM RESOURCES POTENTIAL

The precise location of specific favorable environments within a given GRA depends upon three principal factors:

- The precision and specificity of avaliable data;
- The nature (size and spatial distribution) of anticipated deposits as predicted from known models; and
- The geometry of the favorable geologic environments.

Commodity-specific information in the Lone Mountain GRA is limited. Sub-surface information is virtually non-existent. Therefore, with the exception of geothermal resources, the entire area, rather than specific subareas, has been classified for individual GEM resources (Figure 4-1 and Table 4-1).

The entire Lone Mountain GRA is classified moderately favorable (Class 3C) for metallic deposits[22]. Geologic environments analogous to those occurring in the Pueblo-Steens Mining District are inferred to occur in this study area. The Pueblo-Steens Mining District has produced copper, mercury, and minor amount of associated metals. The confidence level (C) of this classification signifies that the available data (primarily geologic) provide direct evidence to support the classification, but are quantitatively small to support the existence of mineral resources.

The entire GRA also is classified moderately favorable (Class 3A) for potential diatomite resorces. Favorable geologic environments containing beds of ash-bearing, low-grade diatomite are known to occur in the study area[13]. The confidence level (A) of this evaluation is low because it is not known whether commercial-grade diatomite occurs in the study area or whether the appropriate alteration processes have occurred.

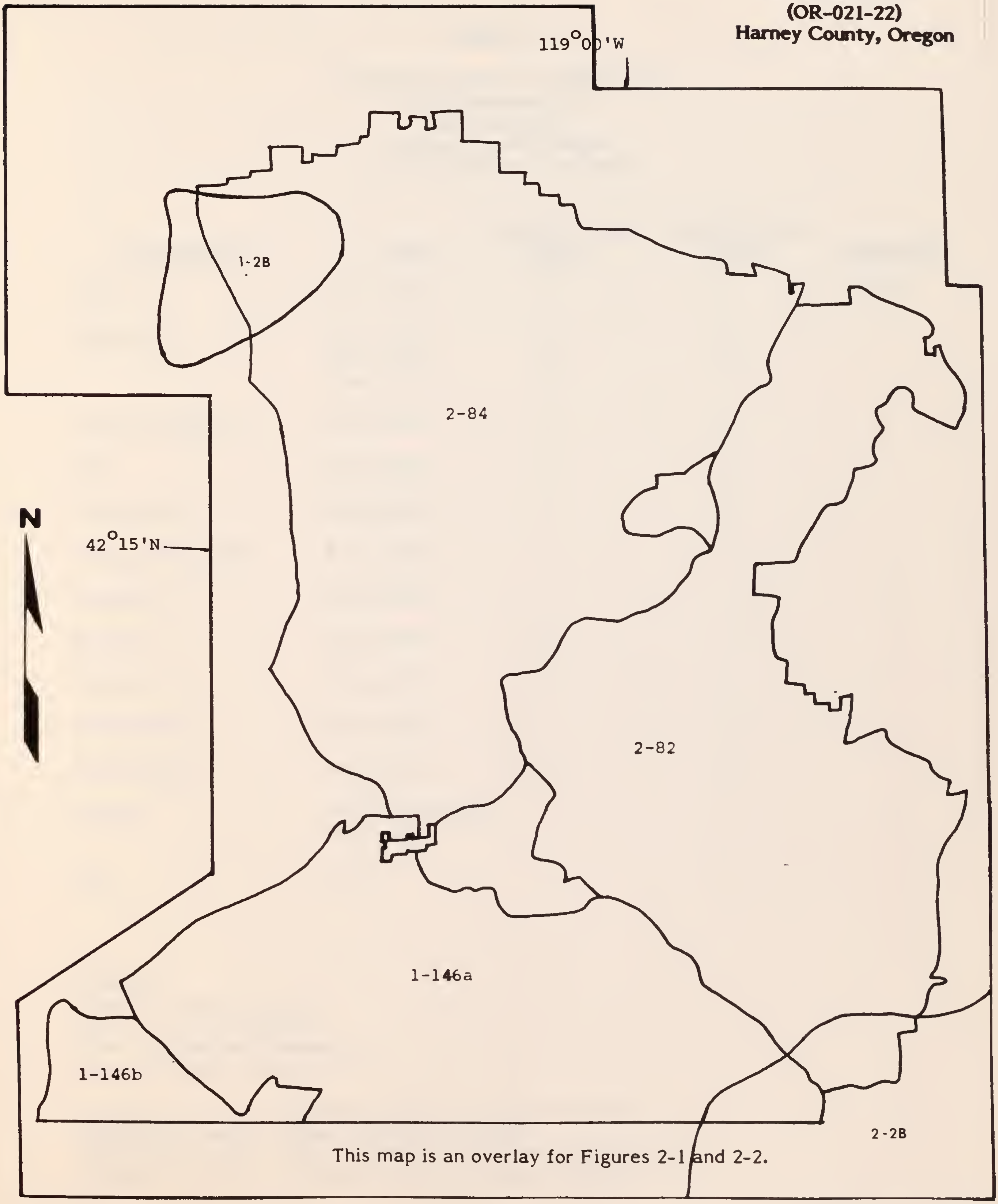
The Lone Mountain GRA has a low favorability (Class 2) for the occurrence of potential geothermal, coal, oil and gas, and bentonite resources. These classifications signify that the apparent geologic environments and inferred processes indicate only low favorabilities for the respective potential resources. The confidence levels of the Class 2 resources range from A to C depending upon the amount, quality, and nature of the available data. Geothermal resources have been classified into subareas within the GRA. Areas 1-2B and 2-2B on Figure 4-1 are more favorable for geothermal resources that the remainder of the GRA (Class 1B). This distinction is based on the proximity of the subareas to areas of relatively young volcanic activity.

The entire Lone Mountain GRA is classified highly favorable (Class 4C) for paleontological resources because of the availability of substantive direct evidence in the form of occurrences of mammalian fossils that support this evaluation(7).

The Lone Mountain GRA does not exhibit favorable characteristics (Class 1) for the occurrence of other GEM resources (Table 4-1). Confidence levels of the Class 1 evaluations range from A to C depending upon the quantity and quality of available direct or indirect evidence.

FIGURE 4-1

Land Classification Map
Lone Mountain GRA
(OR-021-22)
Harney County, Oregon



Scale 1:250,000
(Adel and Vya 1°x2° NTMS Quadrangle)

TABLE 4-1

Classification Of Lands Within The
Lone Mountain GRA
(OR - 021 - 22)
Harney County, Oregon
For GEM Resource Potential

COMMODITY	AREA	CLASSIFICATION LEVEL	CONFIDENCE LEVEL	REMARKS
Metals	Entire GRA	3	C	Cu, Hg
Geothermal	Area 1-2B	2	B	
	Area 2-2B	2	B	
	Rest of GRA	1	B	
Uranium/Thorium	Entire GRA	1	A	
Coal	Entire GRA	2	C	
Oil and Gas	Entire GRA	2	B	
Tar Sands/Oil Shale	Entire GRA	1	C	
Limestone	Entire GRA	1	A	
Bentonite	Entire GRA	2	A	
Diatomite	Entire GRA	3	A	
Clinoptilolite	Entire GRA	1	A	
Paleontology	Entire GRA	4	C	
Hazards	See Hazards Map (GRA File)			
ESLs	None	1	C	

LEGEND:
Class 1 - Least Favorable
Class 2 - Low Favorability
Class 3 - Moderate Favorability
Class 4 - High Favorability

Confidence Level A - Insufficient data or no direct evidence
Confidence Level B - Indirect evidence available
Confidence Level C - Direct evidence but quantitatively minimal
Confidence Level D - Abundant direct and indirect evidence

5. RECOMMENDATIONS FOR FUTURE WORK

Further work in the Lone Mountain GRA should be designed to increase the confidence levels of the classifications. Detailed surface investigations should be undertaken for recognition criteria for industrial minerals (e.g., weathering phenomena that might produce bentonite, clinoptilolite; ash flow tuffs with possible basal vitrophyres for perlite, etc.); for additional metallic deposits, such as soil chemistry, stream sediment analyses, etc. With the exception of either geophysical investigations or drilling, future work should be confined to detailed mapping, geochemical sampling, and general field exploration. Specific attention should be paid to those portions of WSA 2-82 that contain claims.

- APPENDIX A -

References Cited

REFERENCES CITED

1. GeoData International, Inc.; 1979; Aerial radiometric and magnetic survey, Adel national topographic map, Oregon; United States Department of Energy, Open-File Report GJBX-104(80), 153p., 112 fiche.

2. Fay, W.M., Cook, J.R.; 1982; Gold analysis by neutron activation from SRL NURE samples; Savannah River Laboratory; United States Department of Energy, Open-File Report PGJ/F-045(82), 34p., 11 plates, 1 fiche.

3. Geo-Life, Inc.; 1979; Aerial radiometric and magnetic survey, Vya national topographic map, Nevada; United States Department of Energy, Open-File Report GJBX-136(79), Vol. I, 150p., 110 fiche, Vol. II, 73 illus.

4. Dole, H.M., and Weissenborn, A.E. (Eds); 1969; Mineral and water resources of Oregon; Report to the Committee on Interior and Insular Affairs, United States Senate, 90th Congress, Second Session.

5. McIntosh, W.L., and Eister, M.F.; 1981; Geologic map index of Oregon; United States Geological Survey.

6. Newton, V.C., Jr.; 1982; Geology, energy, and minerals resources appraisal, BLM Region I, Columbia Plateau - oil and gas; for TERRADATA, Lakewood, Colorado, unpublished report (this report has been placed in the appropriate GRA files), 20p., plates.

7. Firby, J.; 1982; Geology, energy and minerals resources appraisal, BLM Region I, Columbia Plateau - paleontology; for TERRADATA, Lakewood, Colorado, unpublished report (this report has been placed in the appropriate GRA files), 124p.

8. Rimal, D., Simontacchi, D., and Brown, G.; 1980; Reconnaissance geochemical stream sediment survey of the Hawks Mountain and the Lone Mountain areas, Harney County, Oregon; United States Bureau of Land Management, Oregon State Office, 26p.

9. Budding, A.; 1982; Phase one geology, energy, amd minerals resources assessment, BLM Region I, Columbia Plateau - oil shale and tar sands; for TERRADATA, Lakewood, Colorado, unpublished report (this report has been placed in the appropriate GRA file), 12p.

10. Youngquist, W.; 1982; Geology, energy, and minerals resources appraisal, BLM Region I, Columbia Plateau - geothermal; for TERRADATA, Lakewood, Colorado, unpublished report (this report has been placed in the appropriate GRA files), 65p.

11. Miller, R.; 1982; Geology, energy, and minerals resources appraisal, BLM Region I, Columbia Plateau - uranium and thorium; for TERRADATA, Lakewood, Colorado, unpublished report (this report has been placed in the appropriate GRA files), 20p., plates.

12. Mason, R.S.; 1982; Geology, energy, and minerals resources appraisal, BLM Region I, Columbia Plateau - coal; for TERRADATA, Lakewood, Colorado, unpublished report (this report has been placed in the appropriate GRA files), 5p.

13. Schilcker, H.G.; 1982; Geology, energy, and minerals resources appraisal, BLM Region I, Columbia Plateau - industrial minerals and geologic hazards; for TERRADATA, Lakewood, Colorado, unpublished report (this report has been placed in the appropriate GRA files), 56p.

14. Carrico, L.C.; 1981; Mercury; in Bureau of Mines Mineral Yearbook, 1981, United States Department of the Interior, United States Bureau of Mines, pp.7.

15. Carrico, L.C.; 1982; Mercury; in Mineral Commodity Summaries, 1982; United States Department of the Interior, United States Bureau of Mines, 183p.

16. Carrico, L.C.; 1982; Mercury; in Mineral Industry Surveys, United States Department of the Interior, United States Bureau of Mines, Division of Non-Ferrous Metals, pp.2.

17. Butterman, W.C.; 1980; Copper; in Bureau of Mines Mineral Yearbook, 1980, United States Department of the Interior, United States Bureau of Mines, pp.31.

18. Butterman, W.C.; 1982; Copper; in Mineral Industry Surveys, United States Department of the Interior, United States Bureau of Mines, Division of Non-Ferrous Metals, 9p.

19. Butterman, W.C.; 1982; Copper; in Mineral Commodity Summaries, United States Department of the Interior, United States Bureau of Mines, 183p.

20. Meisinger, A.C.; 1982; Diatomite; in Bureau of Mines Mineral Yearbook, 1981; United States Department of the Interior, United States Bureau of Mines, 36p.

21. Meisinger, A.C.; 1982; Diatomite; in Mineral Commodity Summaries, 1982, United States Department of the Interior, United States Bureau of Mines, 183p.

22. Weis, P.L.; 1982; Geology, energy, and minerals resources appraisal, BLM Region I, Columbia Plateau - metals and non-metals; for TERRADATA, Lakewood, Colorado, unpublished report (this report has been placed in the appropriate GRA files), 24p.